Open Literature Review Summary

Chemical Name: Imidacloprid

CAS No: 138261413

MRID: 47800531~~2~~

Record Number and Citation:

E.C. Yang, Y.C. Chuang, Y.L.Chen "Abnormal foraging behavior induced by sub-lethal dosages of imidacloprid in the honeybee." Entomological Society of America (2008) 1743-1748

Purpose of Review (DP Barcode or Litigation):

Registration Review Risk assessment

Date of Review:

8-16-09

Summary of Study Findings:

Methods: Three colonies of honey bee were used in the experiment. Foragers were trained to fly to an artificial feeder and were gradually trained to fly to an experimental station approximately 35 m away from the hives. The artificial feeder was filled with 50% sucrose solution (wt:vol).

~~This study addresses sub-lethal effects of imidacloprid on honeybee foraging ability.~~ Imidacloprid (95% purity~~TG~~) was prepared in 12 stock solutions between 40 and 6,000 mg/liter in acetone or dimethyl sulfoxide and diluted to the final concentrations in 50% sucrose solutions. The final concentration of solvent in the sucrose solution was equal to 0.1% (vol:vol). Forager bees were individually labeled with various colors painted on the dorsal surface of the thorax. The observed foraging behavior was the time period ~~that a honey bee~~between visits from the same experimental feeding site ~~twice~~. The time interval between feeding visits was recorded for one hour. The authors reported that within one hour of foraging, the bees showed normal foraging behavior. After one hour, the artificial feeder was replaced with a feeder of sucrose solution containing imidacloprid. After feeding the imidacloprid solution once, the artificial feeder was replaced again by a feeder without imidacloprid, and the feeding intervals were recorded for 1.5 hrs. The same procedure was followed for all groups that were individually fed with different concentrations of imidacloprid. All experiments were carried out from 1000 to 1600 hours on sunny days only from May 2006 to March 2007. During the experiments the temperature ranged from 22.6 to 32.8°C.

Results: The study authors reported that ~~A~~a bee's normal visiting time based on the control group is T<300 sec (T≈150 s where N = 18). -DMSO was used as the solvent because acetone appeared to alter the feeding behavior of the bees. Honeybees that showed normal foraging behavior and regularly visited the artificial feeder with a return interval <300s were used for the imidacloprid exposure part of the experiment.

This foraging time increased with imidacloprid exposed bees. Imidacloprid doses used in this experiment ranged from oral amounts of 40 to 6,000 µg/L. Imidacloprid doses greater then 50 µg/L lead to disorientation of bees foraging behavior. The percent of abnormal behavior

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increased with larger amounts of the pesticide. At concentrations of 50, 100, 200, 400, 600, and 800 µg/L, the percentages of abnormal foraging behavior (as defined as T > 300s) were 15.2 ± 4.4, 36.7 ± 11.6, 33.5 ± 12.8, 74.1 ± 13.3, 78.5 ± 8.8 and 83.3 ± 8.3%, respectively. At concentrations greater than 1200 µg/L, all of the bees showed abnormal foraging behavior. The study authors also attempted to estimate the dosage of the bees from the imidacloprid solutions. The authors report that the meal size range was from 36.3 to 86.5 µg/L per bee (unpublished data based on spectroscopic quantification, though this methodology was not described earlier in the methods section), indicating that the dosage inducing abnormal feeding at 50 µg/L could be as low as 1.82 to 4.33 ng/bee. At concentrations of 600, 800, 1,200, and 3,000 µg/liter, the percentages of missing bees were 34.4, 50, 68, 93.3, and 96.9%, respectively. At the maximum doses, 4,000 and 6,000 µg/L, all of the bees went missing.

At concentrations less then 1,600 µg/L, the bees experienced some recovery from symptoms by returning to feeding stations, but only 77.4, 63.6, and 48.4% of the missing bees returned to the feeding site at 3,000, 4,000, and 6,000 µg/L, respectively. The recovery rate correlated with the amount of imidacloprid ingested, the higher the amount of contaminated solution the less likely recovery became. Irregular feeding behavior was observed from the bees that returned to the feeding stations, indicating that full recovery from imidacloprid sucrose solution was not achieved.

Another effect was not only abnormal feeding but when the onset of symptoms occurred. At higher doses of 800 to 6000 µg/L effects could be seen within the first 10 minutes~~immediately~~. For lower doses of imidacloprid at 50 to 600 µg/L, the ~~maximum~~ effects on foraging were ~~seen up to~~irregularly distributed during the 90 minutes of observation ~~after ingestion~~but did not occur immediately after treatment. ~~This demonstrates that imidacloprid can present signs quickly or have a delayed response depending on the dosage and which metabolite is involved in the exposure.~~

Description of Use in Document (QUAL, QUAN, INV):

Qualitative

Rationale for Use:

This study presents useful findings on the behavioral effects of imidacloprid at sub-lethal doses. The study shows that imidacloprid can significantly decrease feeding frequency and disrupt feeding patterns at levels of exposure below the LD_{50}. At the highest levels tested, imidacloprid induced the complete disappearance of all of the foraging bees. This demonstrates that imidacloprid can present signs quickly or have a delayed response depending on the dosage and perhaps which metabolite may be involved in the exposure..

Limitations of Study:

For chronic exposure that exact amount of imidacloprid in the bee at any one time can~~-~~not be accurately assessed. Residues of imidacloprid and the metabolites were not individually analyzed and confirmed in the sucrose solutions to determine the composition in the feeding

solutions. Inadequate information was provided on the health of the bee colonies from which the foragers were obtained, and the methods section did not provide any information on how the bees were obtained from the colonies or managed during the experiment. It is also unclear how the bees were assigned to the treatment groups. It is not clear if bees could have foraged in other areas or how the bees were separated in the treatment groups. It is also unclear how the trials were arranged in time. This lack of description in the separation of time and space for each treatment group and experiment presents a major uncertainty regarding the conclusions of this study.

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